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SECOND QUARTER, 1928.

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EDITORIAL.

FOR some years the *Agricultural Circular* was published by the Agricultural Department and it met with a favourable reception among the planters of the Colony. It was discontinued pending a decision on the question of the formation of a semi-official Agricultural Society that would have issued a quarterly as its official organ. It was decided last year not to proceed with the formation of a Society and an amount was then placed on the Estimates for 1928 to enable a quarterly to be issued by the Department. The Estimates were not approved in sufficient time to enable a number to be issued for the first quarter of 1928 and this first number is therefore in respect of the second quarter and the first volume will contain three numbers only. The Editor hopes that the new publication will be as favourably received among the planting community as was the Circular and he will welcome any suggestions for its improvement.

The report of the Imperial Agricultural Research Conference held in London in 1927 has been received. This Conference marks an important step in the progress of agriculture within the Empire, and attention is invited particularly to a summary of the work accomplished by the Conference, by the Chairman of the Conference, the Rt. Hon. Lord Bledisloe, K.B.E., reprinted in this issue of the quarterly. It is interesting to note that the next Conference is to be held in Australia in 1932.

IMPERIAL AGRICULTURAL RESEARCH CONFERENCE, 1927.

GENERAL REVIEW OF THE WORK OF THE CONFERENCE.

(Speech by the Chairman, the Rt. Hon. Lord Bledisloe.)

You will expect from me, as your Chairman, some short summary of the results of our deliberations, so far as I have been able to visualize them, and I propose, with your approval, assembled as we are here on very historic premises which are the home of the Mother of Parliaments, to adopt what I believe for many generations has been, on such occasions as this, the usual Parliamentary practice, namely, to move, at the end of what I have to say: "That this Conference be now adjourned," and having made that motion to invite any of those present who desire to do so to offer any general remarks upon the utility of the Conference, upon the possible realisation of its ultimate aims and any suggestions, and this I say with the approval of the representatives of Australia, you may think fit to make with a view to the successful conduct of the next conference to be held five years hence in Australia. We are met here to-day to say good-bye; to wish each other Godspeed, and to express the hope that the seed which has this month been sown in what I think I may call well prepared ground may result in a rich harvest for the great Empire to which we are all proud to belong, and especially for its various agricultural communities.

This Conference has, in my judgment, been a great step forward with a view to the spread of ascertained knowledge to meet the needs of the Empire in relation to its most vital industry. It is, if I may say so, an important landmark in Imperial development, and is, I believe, a harbinger of great Imperial prosperity. It has been noteworthy for its comprehensively representative character; the eminence, if I may say so, of its personnel, both scientific and administrative; the unfailing high character of its discussions; the obvious keenness throughout its sittings, and its journeyings; and last, but not least, the unbroken harmony which has characterised its proceedings, and which has smoothed and sweetened them. The Conference has been a big experiment, and I claim for it that it has been an eminently successful one. Its main success, in my humble judgment, has been the mere fact of bringing together distinguished investigators in every branch of agricultural science and able administrators from every part and corner of the Empire, and the pleasant intercourse, friendship, and mutual confidence which have flowed from that simple fact. It may be asked, and no doubt the outside public in every part of the Empire will ask, what, in fact, it has achieved? Apart from the achievements implied in the important fact of its actual meeting, the tangible results may be said to be small, for the very obvious reason that it is not an executive body. It can only advise and recommend, and the carrying out of its recommendations depends, of course, upon the various Governments of the Empire. The majority of its results depend upon the co-operation of the various Governments and their willingness to act upon its recommendations.

What, then, has the Conference done to assist and advise executive Governments? We can point, at any rate, to three main results. In the first place it has surveyed the whole tropical and sub-tropical Empire as a field for agricultural research. It has recommended a scheme of central tropical and sub-tropical research stations. It has defined in general terms the needs which they are to meet; the character of their location and the scope of their work. It has removed some misconceptions as to the place and functions of a central research station in relation to the Government in whose area it is situated. It has made clear its relation to the teaching of agriculture, and it has indicated in a hopeful spirit the sources from which future contributions to central research stations might reasonably be expected. Moreover, it has discussed fully and made recommendations upon what I am sure you will all admit to be two subjects of vital importance to the Empire, namely, the establishment of a central research station in connection with diseases of animals and the further and immediate exploration of the question of a central research station to deal with irrigation.

Secondly, and it is perhaps the most important of all, it has surveyed the question of man power in relation to research. Research, after all, is a matter of individuals, and probably at no conference, no previous conference, has the question how to secure and train the best individuals for research work received more attention, or attention from persons more qualified to speak on the subject. The Conference has indicated the requirements which ought to be looked for in candidates both for specialized work and for posts as agricultural officers. It has fully reviewed the methods of recruitment and the inducements required to obtain efficient agricultural services in the tropical and sub-tropical parts of the Empire. In particular it has brought out clearly and made suggestions towards meeting the difficulty which arises from the predominance of the physical sciences over the biological sciences in almost, if not all educational institutions. It has similarly reviewed the training required for the Empire as a whole. It has considered and systema-

tized the best opinions on the highly important subjects of study, leave and interchange of workers.

It has examined in detail and, indeed, prepared plans for a considerable extension of the existing machinery for co-operation between research workers in different branches of agricultural science all over the Empire. It has by no means confined itself to pious aspirations. It has stated the actual subjects for which further machinery is to be set up, and it has indicated in some detail the nature, the place, and the character of that machinery. Three new bureaux and four correspondence centres will, it is confidently hoped, soon be displaying their vigour as flourishing children of this Conference.

The Conference was called largely to deal with these important administrative problems, but it has not confined itself wholly to their consideration. It would be, of course, utterly impossible to go through all the work which has been done, and most admirably done, and the recommendations which have been made by the various specialist committees. Many of those are covered by the administrative measures which the Conference has recommended. It is perhaps sufficient to say that practically every branch of agricultural science has been surveyed by those who are most familiar with it. Any gaps left in the provision now made have been indicated and recommendations have been made to fill them. One or two examples perhaps I may be allowed to give.

In plant pathology the Conference has drawn attention to the great importance of virus diseases in plants, and has made proposals for a more extended study of the fundamental nature of those diseases. It has pointed out the great importance of insecticides and fungicides in the control of diseases and pests, and has asked for an investigation of the whole chemical field by chemists working in collaboration with entomologists and plant pathologists. It has defined various important questions which urgently need scientific research, and the Conference, through its Veterinary Committee, has surveyed not only many purely technical or local problems in animal diseases, but also not a few which are common to practically all parts of the Empire, such as the elimination of tuberculosis and the methods of control and diagnosis of contagious abortion; and last, but not least, it has possibly for the first time endeavoured to make clear the value and vital importance of the study of agricultural economics.

Of course the results which are embodied in the Reports adopted by the Conference are very far from being all that the Conference has achieved. One result we in this country hope has followed and it will be peculiarly gratifying to us if that hope is fulfilled—is that the research workers from overseas have been afforded a chance, at the cost perhaps of a somewhat strenuous life, of seeing something of a good many of our research men and research stations in Great Britain and Northern Ireland. We hope that they are convinced that the research done there and the facilities which are afforded to the workers, both resident in this country and in other parts of the Empire, are such as to induce an ever-increasing flow of men coming here to learn and refresh themselves and also to instruct our own workers, just as we here realise the value and importance to a man habitually resident here of a visit, long or short, to another part of the Empire.

May I venture to say that, in my opinion, we have, as a result of this Conference, reached important decisions with an imposing measure of unanimity. We may, however, establish bureaux and chains of research stations, and we may train and exchange research workers, but without mutual confidence and the determination to co-operate which it engenders our task would be

in vain. The ultimate results of this Conference it is impossible to visualise and, in all their potentialities it would need a man of extraordinary courage and hypermetropic vision to prophesy the final dimensions of the new structure of which we have this month laid the foundation stone. At least that stone has, in my judgment, been well and truly laid. I have the temerity to believe that there has been no Conference of an Imperial character which has been more harmonious, more definite in its objectives, or more constructive in its deliberations and decisions; or, if I may be allowed to suggest it, more calculated in its results, not only to contribute to the ever-growing solidarity of the Empire, but materially to affect its future prosperity and happiness.

Agriculture we must remember is far the largest industry of the Empire, and for many generations yet will continue to be so. Upon its enhanced productivity as the result of the prudent application of science depends the well-being, the happiness and the contentment of the vast populations of that great commonwealth of nations to which we are all so proud to belong. On the 4th October we met as strangers. To-day we part, I think I may be allowed to say, as firm friends. May that friendship continue to grow for our mutual advantage!

You have thought fit to select as your new central scientific bureaux and correspondence centres certain research stations in this, the old country. Let me say on behalf of those stations that, in no insular or selfish spirit, we accept the Imperial trust which such selection involves and we shall endeavour to justify your confidence by the faithful discharge of our fiduciary obligations. The keen interest which our overseas colleagues have displayed in our own centres of agricultural research (and some of the most important of them still remain to be visited) has kindled the zeal of our British workers and our British administrators and has inspired us with fresh ideals and fresh determination to work earnestly in the cause of Empire development.

It is perhaps, gentlemen, a little unfortunate that your visit has synchronized with a very exceptiona, perhaps unprecedented, depression in agriculture in Great Britain, but I would like to say in that connection that, having worked in the field of agriculture both, perhaps for my sins, as a farmer and also in an administrative capacity for many years, I have a growing conviction that the fortunes of British agriculture lie very largely in the direction of realizing the Empire rather than this nation as the agricultural unit and the consciousness that by co-operation with due delimitation of our respective spheres with fellow agriculturists in other parts of the Empire there may be in store, even for British farmers, a larger measure of economic prosperity in the future.

We say good-bye to you, our overseas friends, with very deep regret, but the retrospect of our pleasant intercourse will always be happy and the prospect of its revival will be a stimulus in the pursuit of our daily avocations wherever they may be. The next Conference is destined to take place in Australia five years hence on the cordial and much appreciated invitation of the Prime Minister of that great overseas Dominion. We are especially glad to learn, by the message from the High Commissioner of New Zealand yesterday, that New Zealand is prepared to co-operate in making the Australian Conference a real success and has offered hospitality after the Conference to those delegates who are prepared to visit that beautiful and interesting part of the Empire. The last words I want to say are these. I do most confidently hope that we shall all do what is in our power to make the next Conference at least as great a success as this Conference has been. I realise—no-one can fail to realise—that there may be some attractiveness to those

who work in distant parts of the Empire to visit the old country from time to time, and to arrange their holidays, or leave, accordingly; but I do venture to hope not only that we who live and work in the old country will do our very utmost to get out to Australia and support the Australian Conference five years hence, but also that those who come from other parts of the Empire will do their very utmost and make up their minds now to set apart if they can a period for the Conference five years hence to visit Australia and to co-operate in making that occasion a big success.

With much regret I beg to move "That this Conference be now adjourned."

IMPORTATION OF NATIVE MATS INTO WESTERN SAMOA.

OWING to the presence of the Coconut Leaf Moth *Levuana iridescens* in this Colony the Government of Western Samoa prohibited the importation of mats, baskets, &c., from Fiji. Representations were made to the Samoan Government on the matter and as a result the importation of such articles is permitted provided they are accompanied by certificates of freedom from disease or have been subjected to fumigation or other treatment for the destruction of disease. Mats and baskets are subject to fumigation on arrival at Apia.

PINEAPPLE FIBRE.

AT the request of Major Willoughby-Tottenham a small sample of pineapple fibre was recently forwarded to the Imperial Institute for examination and report. The Director of the Institute has furnished the following information:—

PINEAPPLE FIBRE FROM FIJI.

The sample of pineapple fibre which is the subject of this report was received at the Imperial Institute on the 2nd February, 1928, and is referred to in letter No. 1473/27 of the 21st December, 1927, from the Superintendent of Agriculture.

It was stated that the sample had been prepared from pineapple leaves by a local planter and it was desired to ascertain whether the fibre could be profitably marketed in the United Kingdom.

Description.—The sample weighed 9 ounces and consisted of two bundles of fine, fairly soft, lustrous fibre, varying in colour from pale brown to light green. The fibre, which had been well separated and cleaned, possessed good strength and had an average length of about 3 feet.

Results of examination.—A representative portion of the sample was submitted to chemical examination, and the results obtained are given in the following table in comparison with corresponding figures for samples of pineapple fibre previously examined at the Imperial Institute:—

	Present sample. per cent.	Pineapple fibre from		
		Malaya. per cent.	Sudan. per cent.	Gold Coast. per cent.
Moisture	8.0	10.7	6.2	9.5
Ash	1.2	0.7	1.4	1.1
(a) Hydrolysis, loss ..	14.0	13.1	12.5	13.7
(b) Hydrolysis, loss ..	17.5	17.9	17.4	19.4
Acid purification, loss ..	3.2	2.9	2.3	1.7
Water washing, loss ..	2.0	2.3	1.2	..
Cellulose	82.7	78.6	82.4	81.5

(Calculated on moisture-free material.)

These results show that the present sample is similar in composition to pineapple fibre from other parts of the Empire.

The ultimate fibres of the material were found on examination to have the usual microscopical characters of pineapple fibre. Their lengths and diameters are shown below in comparison with figures previously recorded:

	Length in mms.			Diameter in mms.		
	max.	min.	mean.	max.	min.	mean.
Present sample	8.0	2.9	4.9	0.0127	0.0025	0.0063
Figures previously recorded	9.0	3.0	5.0	0.008	0.004	0.005

Remarks.—This pineapple fibre is of excellent quality, being generally well prepared and of satisfactory length. Consignments of similar fibre would be readily saleable in the United Kingdom and would probably realise at least £50 per ton at the present time.

Pineapple fibre is not a regular article of commerce in the United Kingdom, as it has usually been found that the cost of extracting it by hand is too high to make shipment profitable, and there does not at present appear to be any machine available which will do the work successfully. In the circumstances, it is suggested that information should be furnished to the Imperial Institute as to the quantity of fibre which could be produced annually in Fiji by the methods at present available in the Colony, and the lowest price which would make the export of the product remunerative.

INQUIRIES CONCERNING ESSENTIAL OILS.

THE following letter has been received from Messrs. Wilson & Mansfield which may be of interest to planters and exporters:—

“The Director, Department of Agriculture, Fiji.

“Dear Sir,

24th March, 1928.

“We have been making inquiries as to fresh sources of supply for Natural Essential Oils and allied products within the Empire, and seeing an exhibition of various Fijian products in the Museum of the Imperial Institute, from the Department of Agriculture, we take the liberty of writing you to ask you if any of the following are produced on a commercial scale in Fiji, and if so, would you be so good as to tell us how we could obtain the names of the producers or shippers. We would like to explain that we are importers and distributors of Essential Oils, &c., and have a regular demand not only here but in foreign countries.

“The following interest us particularly:—

“*Lemon Grass Oil.*—There is a steady demand for this oil, especially if it contains high percentage of citral to compete with that shipped from the island of Comore, the present price being about 3s. per lb to 3s. 3d. per lb c.i.f. packed in drums for oil testing not less than 75 per cent. citral.

“*Cinnamon Bark Oil.*—A small trade; prices from 2s. per ounce to 7s. according to grades.

“*Cinnamon Leaf Oil.*—A steady demand for oil with a eugenol content of not less than 88 per cent. similar to Seychelle variety.

“*Cardamom Oil.*—A very small trade. Practically all the oil used is distilled in Europe from imported Cardamoms; not worth considering.

“*Limes.*—We import lime-juice, raw and concentrated; also hand-pressed and distilled lime oils from the islands in the West Indies.

"If any one was interested in receiving information about the trade in these products we would write them fully.

"We also import from various parts of the Empire and foreign countries, or are otherwise interested in Vanilla beans in fairly large quantities:—

"Ginger root (dried), Tumeric, Cardamoms and other spices such as Nutmegs, Cinchona bark, Papain, Bay oil, and essences of lemon, orange and all kinds of Citrus fruits.

"We would like if possible to receive some particulars of oils of Macon and Dilo, as they are not known to us under these names.

"We would be pleased to supply any information regarding the market here or abroad for any article of produce, and value samples.

"Hoping that we may be of some service in this respect.

"We are, &c.,

"WILSON & MANSFIELD."

ENTOMOLOGICAL RECORDS.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

THE fruit fly *Dacus passifloræ* has recently been bred from cotton bolls (Kidney and Meade), grenadilla buds and pawpaw, all being fresh records for this pest.

The bug *Germalus pacificus*, Kirk, has been found abundantly in both nymph and adult stages feeding upon lantana berries.

The Pentatomid *Coleostichus sordidus* also feeds upon lantana berries, but only adults have so far been observed.

Several parasites have been reared from the Pink Roll worm *Platyedra gossypiella*. Amongst these an, as yet, unnamed Chalcid was found to be destroying 15 per cent. of the pupæ at the Cotton Experimental Station at Sigatoka.

The cotton pests *Dysdercus insularis*, St., and *Tectocoris lineola*, F., were both found feeding upon the fruits of an unidentified species of *Sterculia* on Ovalau. The *Dysdercus* was in great numbers.

PROGRESS REPORT ON THE COCCINELLIDAE IMPORTED FROM TRINIDAD TO CONTROL ASPIDIOTUS DESTRUCTOR.

By T. H. C. TAYLOR, Assistant Entomologist.

1. *Species introduced*.—Five species were landed in Fiji on 6th March. These were:—

(1) <i>Cryptognatha nodiceps</i> , Mshl.	1,517
(2) <i>Azya trinitatis</i> , Mshl.	162
(3) <i>Pentilia insidiosa</i> , Muls.	22
(4) "Spotted" sp. (unidentified)	69
(5) "Small" sp. (unidentified)	400

The figures indicate the numbers landed alive in the Trinidad cages.

2. *Preliminary attempts at breeding in Fiji.*—Although the numbers landed were small in some cases they would have been ample for breeding purposes had the conditions prevailing in Fiji been the same as those in Trinidad. With the exception of *C. nodiceps*, however, none of the species bred satisfactorily.

It is possible that the very wet, cold weather which prevailed during April partially accounted for the failure of these species; but the fact that they bred satisfactorily during the voyage from Trinidad, in spite of the very adverse conditions (notably, extreme heat, great humidity and partial darkness) to which they were at times unavoidably subjected, testifies to their hardihood and makes it improbable that climatic conditions in Fiji were in any way responsible for their failure.

All the species except (1) were heavily attacked by ants in the Fiji cages, and there is no doubt that ants were the chief cause of the failure. Species (3), (4) and (5) were almost wiped out by them. Ants have been observed attacking and carrying off living larvæ and pupæ of these three species. This difficulty was largely overcome by tanglefooting the cages and varas, but in the meantime the stock of beetles had become so depleted in all species except *C. nodiceps* that it was considered too risky to leave the few remaining adults in the cages. We therefore decided to attempt breeding in tubes in order that closer watch might be kept on all individuals and ants completely excluded. Tube-breeding has presented many difficulties however, and although it saved the situation, we now have no more individuals of species (2), (3) and (5) than we had on 6th March.

It is almost certain that *C. nodiceps* is also attacked by ants, but we have come to the conclusion that its success, in spite of ants, is due to the fact that it has been present from the first in much larger numbers than the others, so that the number destroyed by ants is negligible by comparison. Further, the life cycle of this species is shorter, and its rate of multiplication therefore greater than any of the others; hence it is better able to withstand the attacks of ants.

3. *Cryptognatha nodiceps.*—Tube breeding proved satisfactory for this species, but is unnecessary. It multiplies so rapidly in the cages that we sometimes have great difficulty in maintaining a sufficient supply of scale, but the chief difficulty arises through its very strong cannibalistic tendencies, even when an abundant supply of scale is present.

Two colonies of *C. nodiceps* have already been liberated, and we hope to have sufficient adults (about 1,000) for three more colonies a fortnight hence.

4. *Azya trinitatis.*—This species has been very disappointing. In Trinidad, except for *C. nodiceps*, this is the most efficient species, yet in Fiji it will scarcely breed at all; and although ants have been troublesome at times they are now completely excluded. We cannot yet explain the failure of *Azya* satisfactorily. It will not oviposit in tubes, and even in the cages very few eggs are laid. Many larvæ die for no apparent reason, and those which survive grow extremely slowly. On the ship it bred well in the cages without much attention, even when the food supply ran short, and its failure in Fiji is therefore all the more puzzling. The most satisfactory method of breeding it seems to be to enclose the adults in thin cloth bags over varas, an alternative measure which was adopted with great success for all species on the ship. The only explanation which we can offer for the failure of *Azya* is that there is some difference between the scale in Fiji and that in Trinidad.

5. *Pentilia insidiosus.*—Adults lay well in tubes, but the majority of the eggs obtained in this way were killed by mildew on the strips of leaf on which

they were laid. This difficulty has now been overcome, but the stock has become very low in the meantime. It will be necessary to continue breeding in the tubes for another month at least, and no adults will be available for liberation for at least two months.

6. "*Spotted*" *sp.*—This species is promising. Much difficulty was experienced with it at first owing to ants, but it laid well in tubes, and by means of tube-breeding we have been able to obtain sufficient numbers to put in a cage, where it is now breeding very well. It is probably unwise to liberate this species until about 400 adults are available and this will not be for another month or more.

7. "*Small*" *sp.*—This species is particularly liable to be attacked by ants, and it is the only one which is attacked by them in the adult stage as well as in the early stages. At present, tube-breeding, which proves satisfactory, must be continued. One colony was liberated on Wakaya in March, but there will not be sufficient adults for further colonies for some time yet.

8. *Liberations.*—Colonies have been liberated as follows:—

C. nodiceps.—(1) 500 at Koro Levu, Wakaya, on 10th March by R. W. Paine; (2) 400 at Garani, Gau, on 2nd April by T. H. Taylor.

"*Small*" *sp.*—(1) 100 at Koro Levu on 10th March by R. W. Paine

We are of the opinion that it is unwise to liberate less than 400 adults at any one time. A study of the habits of the adults indicates that the best time to liberate them is from a week to a fortnight after they emerge.

9. *Reports from Wakaya.*—On 10th April we received a letter from Mr. de Mouncey saying that the tree on which *C. nodiceps* was liberated at Wakaya had "hundreds on." They evidently had just completed one generation. On 3rd May we received a further report from Mr. Hunt, of Wakaya, who said that the tree was absolutely covered with "white bugs with many long legs." We showed him the larvæ of *C. nodiceps* and he said they were certainly the same as the "many-legged" creatures. We believe these reports to be sufficiently reliable, and therefore feel fairly confident that *C. nodiceps* has become established on Wakaya.

10. *Relative importance of the five species.*—We are now in a position to estimate the relative importance of the five species in Fiji. The order of importance in Fiji as compared with that in Trinidad is probably as follows:

Fiji.		Trinidad.
(1) <i>C. nodiceps.</i>	....	<i>C. nodiceps.</i>
(2) " <i>Spotted</i> " <i>sp.</i>	....	<i>A. trinitatis.</i>
(3) <i>P. insidiosa.</i>	....	<i>P. insidiosa.</i>
(4) " <i>Small</i> " <i>sp.</i>	....	"<i>Small</i> " <i>sp.</i>
(5) <i>A. trinitatis.</i>	....	"<i>Spotted</i> " <i>sp.</i>

It now seems very probable that *C. nodiceps* alone will do all that can be done to control the scale by natural means in Fiji, and even if the other four species also become established we are inclined to doubt whether their presence will materially increase the control. We propose to continue breeding the others if possible, but should one or more of them die out we think it would make no difference to the ultimate result. Certainly the prospects in the case of *C. nodiceps* are very good.

11. *Scale supply.*—There is, as usual, much difficulty in maintaining a sufficient supply of scale. The present generation of *C. nodiceps* alone has consumed all the scale on 35 large varas, all of which were absolutely covered with it two weeks ago. We are now satisfactorily supplementing the food-supply with scale from mango trees and baringtonia. Scale is still available

on the coconuts beyond Cawaci. In view of the comparatively plentiful food supply present on Ovalau it seems desirable to continue to make Levuka the centre for this work.

12. *Life-history work*.—We are making careful observations on the bionomics of these *Coccinellids* and hope within a month or so to have fairly complete records of the life-histories of at least three species.

13. *Elimination of natural enemies*.—Two internal parasites, *Tripolycystus cryptognathæ* and "Coccinellid Parasite II," were found abundantly in Trinidad attacking *C. nodiceps*, *A. trinitatis*, *P. insidiosa* and "Small" sp., and every precaution was taken, both in Trinidad and during the voyage, to eliminate these parasites. Neither of them appeared on the boat from Panama to Fiji, nor after the cages were landed in Fiji, and it is certain that both were completely eliminated. This should materially increase the effect of the *Coccinellids* in Fiji, as compared with Trinidad.

14. *Conclusions*.—

1. The Trinidad *Coccinellids*, considered together, promise well.
2. *C. nodiceps* is almost certainly established in Fiji.
3. *C. nodiceps* is certainly the most promising.
4. Satisfactory methods of breeding all the species, except *A. trinitatis*, have now been evolved.

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STAINED COTTON IN FIJI AND ITS CAUSES.

By H. W. SIMMONDS, F.E.S., Government Entomologist, Fiji.

THERE are in Fiji two types of stained cotton which are of major importance, and which have both caused considerable loss to growers. The first of these shows as a reddish brown discolouration of the lint, commencing at the point on the seed which lies closest to the husk of the boll and spreading in a fan-like manner along the lint fibres. This stain is most in evidence early in the season and, whilst not nearly so abundant as the yellow stain to be described next, caused some anxiety at one time, as it was, in England, supposed to be due to the accidental presence of mineral oil. I found, however, that the bug *Tectocoris lineola*, when not infected by having fed upon diseased material, produced this stain freely in my breeding cages. It seems to be of a mechanical nature, only being produced when no infection is introduced at the time that the seed is punctured by the insect when feeding.

The second and far more abundant type of stain is of almost world-wide distribution, and depends upon the attacks of the various cotton stainers of the genus *Dysdercus* for its distribution. This stain is of a very pale yellowish nature, and is generally diffused over the whole area of the affected section of the boll, not starting from a definite point on the seed as the former does. Early pickings suffer very little from the trouble, but as the season advances, it becomes increasingly abundant, causing very heavy depreciation in the value of the crop.

EXPERIMENTS.

During 1927 a number of experiments were carried out with the Fijian cotton stainer *Dysdercus insularis*, to test the effects of its attacks upon bolls and flower buds, and these are detailed below.

First Experiment.—On May 20th twelve second instar nymphs of this species, which were nearly ready to enter their third stage, were placed,

two and two, into six calico-covered wire cages. The cages were supported on wire rings hung on sticks, and each placed over a flowering shoot of Sea Island cotton. They were inspected from time to time, the growth of the enclosed insects being found to be very slow.

On June 14th all were examined, when it was found that there had been a considerable shedding of flower squares (some 50 per cent.). The enclosed bolls were then cut open and carefully gone over with a lens. No trace of puncture or proliferation was found, and it seems certain that up to the end of the third instar the nymphs are unable to puncture the bolls, but obtain their nourishment from the surface layers of the plant and flower squares, causing some loss of flower buds. In the cages the growth of the enclosed nymphs was very slow, doubtless because, being unable to wander over the plant, they found it difficult to obtain sufficient food in a suitable stage of growth and were partially starved.

On this date (June 14th) only one of these nymphs had entered its fourth instar, whilst the remainder of the brood from which they had been taken, and which had been fed upon young extracted cotton seed, had all entered their fifth instar from two to four days.

Second Experiment (June 14th).—Four specimens of fifth instar nymphs were next placed in two cages to see if, at this stage, they were capable of puncturing the bolls and the effects of such punctures upon the lint. The cages were examined on June 27th, when it was found that in one cage all the bolls except one had fallen off. This one had been heavily punctured and the seeds were rotting. No yellow stain was, however, present. In the second cage one boll was examined and found to be punctured, with typical proliferation. The remaining two bolls were then left to mature in order to observe if any stain was produced; none, however, occurred. It was then decided to commence a fresh set of experiments to check the above, leaving the bolls to mature in each case. These are detailed as follows:—

Third Series.

Bag No.	No. of specimens.	Stage of nymphs.	Date.	Results
1	2	Second instar	9/7/27	Neither puncture nor proliferation.
2	6	Fourth instar	3/9/27	Proliferation but no stain.
3	6	Third instar	8/8/27	Little growth, no puncture or proliferation.
3	1	Fourth instar	15/8/27	Proliferation but no stain.
4	5	Fourth & fifth instar .	11/8/27	Bolls aborted and dropped off.
5	6	Fifth instar	16/8/27	One boll damaged but no stain.
6	4	Fifth instar	25/8/27	Proliferation but no stain.
7	3	Adult	30/8/27	Proliferation but no stain.

In the above experiments all the nymphs and adults used had been reared in captivity from the egg and fed upon clean immature cotton. It will be observed that in no case did second or third stage nymphs produce punctures, but that from the fourth instar onwards punctures, with the accompanying proliferation, were general, but in no case was the typical yellow stain obtained. In two instances, however, rots were introduced and these were also met with in the previous *Tectocoris* experiments.

Laycock in Nigeria (R.A.E. Vol. 14, p. 320) shows that the yellow stain is due to introduced fungus, and the above confirms his results. Laycock, however, found his non-infected nymphs produced a brown stain, apparently similar to that which I obtained from *Tectocoris*. I have, as yet, obtained

no stain of this type from *Dysdercus* in Fiji, and it is possible that our species is of a feebler type and mechanically incapable of producing it.

The experiments carried out this year show that:—

1. The brown stain is produced by *Tectocoris lineola* and is apparently mechanical, being produced freely by insects reared under cover in captivity.

2. That although punctures of the bolls and proliferation take place freely, when fourth to adult stage *Dysdercus* feed upon cotton, no stain is produced upon the lint as a result of such feeding when clean fed *Dysdercus* are used, and that the yellow stain, as also many of the cases of rotting and aborting of the bolls, is due to the introduction of fungus spores by the insects when feeding, after having previously fed upon diseased bolls.

THE HOUSE FLY PROBLEM IN FIJI.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

INTRODUCTION.

EARLY verbal accounts bear witness that house-flies were at one time very troublesome throughout Fiji. These verbal accounts are supported by the following extracts from P. H. Bahr's *Dysentery in Fiji in the year 1910*:—

Page 22.—“House-flies (*Musca domestica*) constitute a great plague in Fiji. They swarm during the hot weather (November to April) in Suva; in the sugar districts they are prevalent throughout the year.”

Page 23.—“The phenomenal preponderance of flies in Fiji, the great frequency of dysentery there, the concurrence of the fly season with the dysentery season . . . are distinctly in favour of regarding Fijian epidemic dysentery as a fly-borne disease.”

Page 9.—“The abolition of epidemic dysentery in a town of the size and importance of Suva depends upon an efficient sanitation, mainly directed against the house-fly.”

About the year 1912 on Vanualevu and somewhat earlier on Vitilevu there was, in many parts however, a great improvement in the position regarding this pest. This improvement was attributed to the work of a small brown ant, *Pheidole megacephala*. The observations on the subject, which were first made by Professor Illingworth, are reported in the Annual Report, Department of Agriculture, Fiji, 1914, page 24; and have been amply confirmed by myself, on many occasions since, at the stables of Messrs. Robinson & Ballantyne.

Despite the improved position in certain parts, however, flies continued to be numerous, and even a plague, in other parts of the Group, notably the Rewa Valley, when, in November, 1919, they actually blackened the ceiling of the dining room of one house I stayed at. Another bad place was (in 1921) Malolo Island and also Taveuni. In Suva the incidence of the pest varies greatly, not only in different seasons, but also in different parts of the town. One of the worst areas is Circular Road, regarding which complaints were made as far back as 1916. Investigations were carried out at that time by the Medical Officer of Health and the Government Entomologist (Mr. F. P. Jepson) when it was supposed that the Chinese gardeners, who used stable manure, brought about the outbreaks (Ann. Rep. Dept. Agric., Fiji, 1916, p. 22). In 1921 further complaints regarding this district were investigated by Dr. Carment (then Medical Officer of Health) and myself. The stable manure dumps, Chinese latrines, cow dung and refuse heaps were examined, without however any definite results. The stable manure used by the gardeners came from Messrs. Robinson & Ballantyne's stables and,

when in the bins, was found to be full of larvae, so that, although neither pupae nor larvae could be found in the dumps in the gardens, this material still remained under suspicion as the origin of the trouble. Now, however, the Chinese gardens have gone, but the flies still remain as troublesome as ever. They are also very troublesome in certain other parts, well removed from stables or stable manure.

At the time of the earlier investigations, and until quite recently, the common Fijian house-fly was supposed to be *Musca domestica*, a species which normally does not breed in cow dung. The common Fijian fly is, however, undoubtedly a different species the name of which is still uncertain. It has somewhat different habits and, as will be shown later on, is now found to breed normally in cow dung.

HOUSE-FLY INVESTIGATIONS IN 1928.

In consequence of the large numbers of flies present towards the end of 1927, I again decided to carefully search cow dung, to see if I could locate where they were breeding. In this search I was successful, finding, on January 22nd, maggots in vast numbers in dung of a certain age, mostly in the lower layers. The first of the adult flies from these maggots emerged on January 29th, and proved to be the common house-fly of Suva.

In order to be certain that this was so, I decided to take a count of flies in my own house, which, adjoining a cow paddock, is much troubled by the pests. I therefore closed the house and, using "fly-tox," collected all flies which fell. I also cleaned out the kitchen and collected, with a net, those present on the benches and lines. Seventy-seven flies were collected in this way and seventy-one, or 92.22 per cent., proved to be this cow dung breeding species. In view of this discovery a series of observations and experiments were made to try to trace the incidence, habits, life history and also other breeding grounds of this pest. These observations are recorded below.

FIELD AND LABORATORY OBSERVATIONS ON BREEDING HABITS AND LIFE HISTORY OF HOUSE-FLIES IN SUVA.

Cow dung was examined in the following localities:—Circular Road, Suva (frequently); Mr. Martin's paddock, Gorrie Street, Suva (several times); Golf Links, Suva; Reclamation, Suva; Wainibokasi River, Suva; Miss Rennie's paddock near Girls' School, Suva. At all of these places fly maggots were found in great numbers, and less frequently, pupae were also discovered. These latter were sometimes present in the drying cakes of dung, at other times in the soil beneath and amongst the surrounding grass roots, whilst on one occasion two were found in some old horse manure adjoining a cow dropping. Weather conditions must have a considerable influence in deciding where the larvae pupate, as also they must determine when the adults can oviposit and, at times, entirely prevent this latter taking place. Undoubtedly there are times when, either directly from this cause, or indirectly from its effect upon the mechanical nature of the crust of the dung, fly maggots are difficult or impossible to find, yet a few days later vast numbers will be present in the same paddock. This is probably the reason why neither the Medical Officer of Health nor myself located, in cow dung, the origin of the pest in Suva when working on this subject in 1921-22.

I find that this fly seldom (if ever) oviposits upon droppings lying in shade. I do not think this is due to the shade directly as such, but, rather, to the slow formation of the crust which does not reach a suitable stage until the whole nature of the dropping has undergone changes rendering it unsuitable to the fly's purpose. The normal habit of the fly seems to be to

oviposit upon droppings of four up to, perhaps, 24 hours of age, which lie in the open, when the droppings have formed a thin, leathery crust, but are still quite soft and fresh beneath. The flies oviposit equally in bright sunshine or dull warm weather, but not in rain.

Egg stage.—The eggs are deposited in the natural folds and pockets formed in this crust in drying, and are laid, a number together in little heaps. As with the European house-fly, *Musca domestica*, there is a marked tendency for a number of females to oviposit close together in the same pocket. On February 3rd flies were observed ovipositing in cow dung in Circular Road between the hours of 10 and 11 a.m. The day was sunny, with a strong south-east wind following rain. The droppings selected were lying in the hot sunshine and I estimated them at the time to be about 24 hours old. In the light of further observations I am of opinion that that estimate was too long and that they were somewhere between six and 12 hours of age. A number of batches of eggs were collected and taken home and the droppings marked for daily observation. The eggs, which were taken home, commenced to hatch at 7 p.m. and had all done so and entered the dung by 9 p.m. The temperature ranged from a maximum of 86° Fahr. to a minimum of about 74° Fahr. at the time of hatching. This gives an incubation period of about nine hours at the above temperature.

Larval stage.—The droppings were examined each day and it was found that the development period of the larvae was surprisingly slow. On the third day they appeared to be barely half grown, on the sixth, however, some of them seemed to have disappeared, presumably having entered the soil to pupate, as a solitary, newly turned, pupa was found just below the dropping.* On the seventh day there were still a very large number of the maggots which had not entered the soil, but the majority of these had done so by the next day, a few however remained until yet another day, being ten days from when ovipositing was observed to be taking place.

Check experiment in laboratory.—A number of eggs from the same dropping and of the same date (February 3rd) were brought away to rear in the laboratory as a check on the field observations. None of these had pupated on the 11th (eighth day), but the majority had entered the soil in preparation. A few however were still in the larval stage on the 12th and some of these had not pupated even on the 15th.† Food shortage may, however, have influenced these latter. The above gives a period of 5½ to 8 or even more days for the duration of the larval stage, with the majority pupating about the eighth day, the weather being cool to average summer weather. Just before pupating it was observed that the larvae had become a clear cream colour due to the absence of food in the alimentary canal. In a second laboratory batch, with abundant food, the first pupation occurred about 6 days 20 hours after the eggs were laid, the balance pupating within the next 23 hours, thus giving a larval period of 6 days 11 hours to 7 days 11 hours.‡

Pupal period.—Digging beneath and around the droppings in the field led to a considerable number of pupae being found. These lay from one

* There is of course a possibility that this pupa did not belong to this batch, but it is unlikely.

† These however all failed to mature.

‡ A large number of this brood completed their cycle from egg to adult in a shade under 12 days. The weather was particularly warm and humid, with a mean maximum for the twelve days of 87·5° F. and a mean minimum of 76·16° F. and an actual maximum of 91° and a minimum of 74°. These temperatures are high, even for the Fijian summer and will sufficiently account for this rather shorter life cycle. For fuller details see Appendix B.

to three inches into the soil, very frequently in the roots of grass, whilst sometimes a number would be found in the dropping itself. Judging by the numbers I was able to find I think the larve must often travel some considerable distance in search of a suitable pupating site. None of the pupae found in the field have as yet proved to be parasitised.

Length of pupal period.—This was also longer than expected and, in the moderate summer weather experienced this season, averaged about six days.

Length of life cycle.—The times for the life cycle work out as follows:—

Incubation period	.. . . .	9 hours.
Larval period	.. . . .	5½ to 8 or even more days.
Pupal period	.. . . .	5½ to 6½ days.

To this must be added the time which elapses between when the fly emerges and the time that it is ready to oviposit. This is uncertain, as I have not yet been able to observe pairing in captivity, although various methods to bring it about have been tried. My bred flies may have paired in the big cage or in the cylinders before being put into the breeding cage. The average period probably lies between three and seven days. This gives a total of fourteen to twenty-one days from egg to egg, which period will probably be found to be even longer in winter.

It is the larval portion of this cycle which is surprisingly long and this may be the important factor affecting the number of flies present, from time to time, in houses. In so long a period it must at times happen that the medium, in which they are feeding, dries out before they have reached maturity or gets washed away in heavy rains. It is also a factor which should assist in any scheme for reducing the pest.

Some idea of the number of flies which can emanate from a cow paddock can be gained from the flies which resulted from the eggs brought away for observation on February 3rd. These yielded 108 adults on the 17th, 190 on the 18th, 68 on the 20th, a total of 366 flies in three days with still more to come at time of writing. These eggs all came from one dropping and did not represent one quarter of the maggots present, which must sometimes run into two thousand in a single dropping.

OTHER INSECTS PRESENT IN COW DUNG.

In addition to the common house fly there are, in Fiji, several other insects which breed in, or about, or haunt cow dung. The commonest of these is the larva of a large *Sarcophagid*, which is very abundant. The adult fly is of filthy habits and is given to entering houses. I bred a large number of a small black *Anthomyid* on one occasion and have also taken this fly in the office. A tiny *Phorid* is abundant, whilst there are a few beetles of the *Aphodiinae* group generally present. A *Staphelinid* beetle, occasionally observed, may be of use as a predator, but is not numerous enough to be of any practical value. No parasites were bred from pupae collected from cow dung, although *Spalangia* sp. (?) was bred from pupae from horse manure. Most of these were bred from *Stomoxys* pupae. I have, as yet, not found them in the open, in either *Stomoxys* or *Musca*, but both *Musca* and *Stomoxys* were attacked in the stables. When bred through in the laboratory this parasite took from 18 to 22 days from egg to adult, using the cow dung *Musca* as host.

OTHER SOURCES OF FLIES IN SUVA.

Search was made to see if any other considerable source of flies occurred in Suva, and such a source was found in the city dump. This was visited in company with Mr. Ellis on January 12th. Flies were observed settled

in swarms upon the surface, whilst the top layers were found to contain great numbers of maggots of several kinds, including *Muscids* and *Sarcophagids*. A number of the former were collected to breed out. These proved to be the same species as bred from cow dung. The area in which the maggots occurred only descended some three or four inches, below which fermentation was taking place, with a temperature too high for the maggots to endure. Comparatively few pupae were found and it is possible that, in this case, there may be considerable mortality at the pupation period.

At this dump the method of disposal of the refuse is to spread it in a fairly thick layer, subsequently covering it with sawdust and grass. As soon as dry enough this is burnt, and it is a considerable time (six weeks) before another layer is placed over it. It was found that burning did not destroy the maggots or render the material unfit for their breeding. Maggots were apparently just as numerous in the freshly burnt area as elsewhere and from that point of view the method is a failure. I am of opinion that if the material were placed in a somewhat thicker layer (so as to reduce the surface area and increase the rapidity of fermentation) and a fresh layer placed over it within eight days, fermentation would destroy large numbers of the maggots, whilst if the surface layers could be turned under just before the new layer was placed on it, such destruction would be very effective. With the completion of the destructor the dump, as a source of flies should, however, disappear.

Horse dung.—Surprisingly few fly larvae were found in the stable bins in Suva, a great improvement on 1921 being observed. This is probably largely due to the use of wood chips instead of straw or sawdust for bedding, as similar results have been obtained in Europe by using shavings or peat instead of straw (B.M. Economic Series No. 1A, page 17).

In all, 77 pupae were collected from stables, and these produced 28 *Stomoxys calcitrans*, and 37 of a *Muscid*, which I am unable to separate from the cow dung species, although a few are somewhat smaller. There were also 12 specimens of a *Spalangia* pupal parasite. These came mostly from Burns, Philp's stables, where the parasitic percentage was over 50 per cent. Horse droppings in the field have also been examined, but only on one occasion have *Muscid* larvae been found and then only two. Ants, *Pheidole megacephala*, swarm over the droppings, and in the stables I have frequently seen them removing eggs and small larvae and they probably account for the absence of larvae from this medium. Cow dung is of very different texture, the eggs are laid whilst the surface is probably too soft for ants to hunt over it and, once hatched, the larvae must be absolutely protected from these predators in the soft semi-liquid interior.

Grass cuttings.—Complaints had also been received of the presence of biting flies *Stomoxys* on the cricket ground and neighbourhood, and it seemed probably that grass cuttings deposited along the sides of the grounds were the source of this pest. These cuttings were therefore examined and it was then found that conditions varied very considerably in different dumps. A certain number of pupae and maggots were found in one or two dumps where the cuttings were damp, rotting and cool, having been deposited in a thin layer and in a damp spot. Where deposited in a thick mass and dry, fermentation was keeping the temperature too high for maggots to endure. It is however possible that in wet weather there may be a layer of these thicker heaps, sufficiently moist and cool for the fly's purpose. Chicken were however working over the heaps and must greatly reduce any flies arising from this source. Of the pupae taken away all proved to be, as expected, *Stomoxys calcitrans*. These pupae were collected 31/1/28 and the

emergences occurred on the 2nd February (1 fly), 3rd (2 flies), 4th (1 fly) and sixth (3 flies), so that the pupal period of this fly may also be as long as six days.

Another examination was made on the 9th February, when neither larvae nor pupae could be found. Further material was however collected at a later date, which also proved to be all *Stomoxys*. No parasites were bred out of any of this material.

FLIES FREQUENTING HOUSES IN SUVA.

In order to confirm my former experience further counts were made of flies in my kitchen. These were made on the 13th January and 24th of the same month. On the 13th some 85 specimens were obtained, 28 being males and 62 females, whilst on the 24th a further 107 were captured, of which 57 were males and 50 females. Subject to examination by a specialist all appear to be the same species as the one I have found breeding in cow dung, the name of which must remain open until definitely identified. A few *Sarcophagids* have also been observed in the house, whilst at the office, *Stomoxys calcitrans* was decidedly in evidence. All the *Sarcophagids* taken seem to be the cow dung breeding species, which is particularly filthy in its adult habits.

HABITS OF THE COW DUNG HOUSE-FLY AND ITS RELATION TO HUMAN FÆCES.

I have shown that this cow dung breeding fly is the common species found in houses in Suva. Its habit is to crawl over plates, spoons, &c., and it is particularly given to sitting on the portion of a cup or glass where anyone has been drinking. It feeds greedily upon sugar, bread, jams and chutney, and leaves its vomit and fæces wherever it settles. It is a thirsty fly and settles on the lips of milk or water jugs for the drops of liquid that lie there when in use.

It is not only a most annoying pest of human beings, being of a particularly persistent and sticky nature, but it is given to settling upon skin wounds of any kind and the lips of small children, with serious risk of carrying infection. On a visit to the Waimanu Road, Suva, where there is often a good deal of Indian expectoration, I observed that the sputum was in each case surrounded by a circle of flies feeding upon it, all of which appeared to be this same species.* I have also observed this same fly upon the fæces of birds and animals, upon human vomit and the discharge of a boil (human). As its relation to human diseases is much bound up in the question whether or not it feeds upon, or breeds in, human fæces, a number of experiments and observations were made to determine its habits in that respect. These investigations were carried out along the following lines:—

Experiment No. 1.—Visits were paid, in company with Dr. Bailey, to the Indian and Chinese latrines about Flagstaff Hill on January 17th and 20th. I found the latrines were kept wonderfully clean and every care taken to minimise danger from this source. Nevertheless flies were practically universally present, although seldom numerous. In the confined space of the latrines they were difficult to catch, but some 27 examples were taken. One of these has been tentatively identified for me by the Superintendent of Agriculture, as *Synthesiomyia braziliensis*, the remaining 26 all appearing to be the cow dung breeding, house haunting species. The flies were

* I have only been able to confirm this observation on one or two occasions since and the attractiveness of the expectoration probably varies according to its contents, or possibly, atmospheric conditions.

observed settled upon the seats, the sides of the pans, and particularly upon the floors, if any liquid, such as urine, had been spilt there. In these latrines a *Sarcophagid* was observed a number of times but in the confined space I was unable to capture any, so cannot be sure as to the species. There is, however, little doubt that it is the cow dung species, as this fly is generally the first attracted by human fæces.

Experiment No. 2.—In the next test human fæces were exposed in the scrub. On this occasion it was found that *Sarcophagidae*, *Trypetidae* and *Ortaliidae* were the flies usually present and no *Muscid* was observed. This experiment was repeated with similar results.

Experiment No. 3.—In the next experiment a group of newly emerged flies, bred from cow dung, were placed in a glass jar and offered cotton wool soaked in honey and water, also pieces of cork with a thin film of human fæces spread upon them. Both were visited by the flies, but they showed a marked preference for the fæces to the extent of at least two to one. The flies were observed to feed upon it and the small drop of saliva which they secrete, in feeding, was distinctly visible. This experiment was repeated a number of times with similar results.

Experiment No. 4.—The most important test was, however, to see whether this fly would breed in human fæces. For this purpose two batches of flies were taken, which had emerged from cow dung on the 30th January and on the 1st February respectively. These were fed upon honey and water until the 6th February, pairing not being observed. At 10 a.m. on February 6th these flies were placed into a large cage which also contained a tin of freshly voided human fæces. Honey and water were supplied for food and the cage visited from time to time, when the following observations were made:—

Date and time.					No. of flies on fæces.	No. of flies on sides of tin.	No. of flies on honey and water.
Feb. 6--10.10 a.m.	..	..	..	..	2	.	.
" 10.30	"	..	..	..	2	.	.
" 11.45	"	..	..	..	1	.	.
" 12.10	"	..	..	..	1	.	.
" 1 p.m.	..	..	..	..	7	3	.
" 2	"	..	..	..	6	.	.
" 2.45	"	..	..	..	9	.	.
" 3.30	"	..	..	..	2	3	.

During this first day the fæces were apparently visited for food only, examination on the morning of the 7th showing no eggs.

Feb. 7--9 a.m.	..	..	..	4	1	.
" 7 noon	..	..	..	5*	.	.
" 7 2 p.m.	..	..	..	5	.	3

* All apparently ovipositing, fæces had begun to harden.

By their going to the honey it seemed possible that they might be thirsty, so the cage was sprayed with water.

Feb. 7 3.30 p.m.	..	..	..	6	.	.
" 8 8.40 a.m.	..	..	..	7	.	.
(away rest of day.)						

Feb. 9, 11.30 a.m.—The fæces were examined and found to full of small maggots and a number of batches of hatched eggs observed. These had apparently all been deposited on the 7th.

Feb. 10.—Fæces removed from tin and placed into a pan with soil and moistened.

Feb. 15.—The majority had entered the soil to pupate at 9 a.m., a few of the pupæ being found at 3 p.m. The great mass however did not pupate until the night of the 16th/17th and morning of 17th.

The larvae thus took nearly eight days from egg to pupa as a minimum. Food shortage may have prolonged it slightly but I do not think so, as it approximates very closely to those bred in cow dung, whilst the pupæ were mostly of full size, as also were the adult flies, when they emerged. The first of these adults emerged on the night of the 19th/20th, 12 males and 10 females up to noon, *i.e.*, 13 days from the time the eggs were laid, whilst the majority emerged on the 22nd and 23rd. The pupal period was carefully checked and worked out at $5\frac{3}{4}$ to $6\frac{1}{4}$ days (see Appendix B).

SUMMARY.

It is now certain that the principal source of house flies in Vitilevu is cow droppings as they lie in the field. The city dump is an additional source in Suva, whilst the pest will also breed in stable manure. In this latter situation however ants destroy quantities of the eggs and maggots, so that the most important origin of the pest is undoubtedly cow manure. The fly is filthy in its habits, feeding upon human expectoration, vomit, the fæces of dogs, fowls, &c., and also feeds upon and breeds in human fæces.

The biting fly *Stomoxys calcitrans* seems to have become much commoner than formerly and a high proportion of the pupæ collected in stables proved to be this species. It was also the only species found in rotting grass cuttings. It is not a common house-fly, but bites in the open. It is elsewhere under grave suspicion as the vector in anthrax, infantile paralysis and certain trypanosome diseases.

CONTROL OF FLIES BREEDING IN COW DUNG.

The possible methods of controlling cow dung breeding flies divide themselves into two sections:—

1. Mechanical or artificial control.
2. The introduction of natural controlling agencies.

1.—*Artificial Control.*

In the closely-settled areas such as Suva, the prohibition of cattle would undoubtedly prove an effective method of dealing with the pest. The less drastic method of spreading the dung could alternatively be applied to certain areas. This would require to be done whilst the dung was sufficiently soft to spread thinly and also sufficiently frequently to expose the larvae whilst still small, as I have observed that when they reach a certain size they burrow into the ground if their food gets too hot, returning again to feed when it cools down in the evening, whilst a lump the size of a cricket ball will support a large number of maggots. I think it would be necessary to spread the dung twice a week, perhaps oftener.

The above mechanical methods could, of course, only be applied to restricted areas and would not be practicable in large districts such as the Rewa Valley, where flies are particularly prevalent, or to Taveuni, where they are equally troublesome, although I do not, as yet, know that in the latter place we have to deal with the same species. In those cases some method of natural control is desirable if a promising one can be found.

2.—Natural Control.

In other parts of the world two house flies, viz., *Musca autumnalis* in Europe and *M. enteniala* in India, are known to breed in cow dung, whilst *M. bezzi* and one or two others in India use the same medium, but I have no record whether they are house flies, as the two former ones are.

In Malaya the house fly has not been definitely identified, but *Musca sp.* (?) *Bakeri* (?) is recorded as breeding in horse and cow dung by Gater and although he does not actually state that this is the one found in houses the text infers it. Gater does, however, state that "the house-fly is not very abundant, but that plagues do sometimes occur," and traces the origin of one such (Bull. No. 83, Malaya Agri. Dept., p. 36). My own experience in that country was that, despite the great number of cattle present, also buffalo and wild oxen, flies were so scarce as to be a subject of comment when observed in the houses, and if their house fly does, as suggested, breed in cow dung, it must be under extremely efficient control. This also applies to Java.

There is another fly, however, which breeds in cow dung and which has become a major pest in certain parts of the world and that is the Horn fly, *Lyperosia irritans*. In parts of America it makes it impossible to fatten cattle at certain seasons, and in the Hawaiian Islands it has become a most serious matter to cattle raisers. Allied or identical forms are also pests in other parts of the world, notably Northern Australia. In the Hawaiian Islands serious attempts to control it have been made, working along two lines of research:—

1. By the introduction of parasites and direct predators such as *Staphelinidæ* and *Carabidæ*.

Of parasites we have in Fiji only the *Spalangia*, recorded above, and this I have as yet not recovered from cow dung bred pupæ. Of the predators, both groups are very poorly represented in Fiji and the introduction of certain of them should prove beneficial from many points of view. A large *Staphelinid*, *Creophilus erythrocephala* imported into Hawaii from Australia, bred freely in captivity and fed upon maggots in cow dung (Rep. of Commr. of Agri. and Forestry, Hawaii, 31/12/22, p. 57).

2. The second method which is the one upon which the Hawaiian authorities are placing the most importance is to destroy the dung by means of dung-burying beetles. It would therefore be well to compare the early stages of the two flies under consideration:—

<i>Fijian house fly.</i>	<i>Hawaiian Horn fly.</i>
Oviposits in cow dung some hours after deposited.	Oviposits in cow dung immediately it is dropped.
Bulk of larvae take 7 or 8 days in summer to mature, full-fed larvae being present in dung of 8 or 10 days of age.	Full-fed larvae found in dung of 4 to 6 days of age.

From the above it will be seen that any agency which destroys the dung will have about double the time in which to complete the work in Fiji against the house fly to that which it has in Hawaii against the Horn fly. So that any measure of success which may have attended their efforts there, can be hoped for to a far greater extent here, against our slower breeding insect, employing the same agencies.

Birds were also suggested for their problem, the American Cow bird being one, which, living specially upon larvae in cow dung, was particularly under consideration. It was however discarded on the grounds that it might eat rice. A bird to which I think no objection could be raised is the Australian Wagtail; it however generally catches its prey on the wing*.

On the whole I am of opinion that dung-burying beetles offer the most promising line of investigation for natural control with a view to dealing with the pest over Fiji as a whole. I have therefore made inquiries in Hawaii to see what, if any, measure of success has attended their efforts and will report on receipt of reply. I have also written to Malaya to ascertain definitely if their cow dung *Musca* is also their house fly and, if so, what agencies hold it normally so efficiently in check.

In Malaya I noticed flies, in very small numbers, on the faeces of cattle. These would be, almost certainly, *Lyperosia exigua*, allied to the European Horn fly *L. irritans* and which breed in cow dung. Their small numbers suggest that the natural control of cow dung maggots is, in that country, extremely efficient.

APPENDIX A.

AGE OF DUNG USED BY FLIES FOR OVIPOSITING.

In my earlier reports I gave 24 hours as the approximate age of cow dung when used by the house fly as a medium in which to oviposit. I now find that in dry, hot weather this time may be considerably shortened. Marked dung of four hours had formed a crust almost suitable and flies have been observed settled upon, but not ovipositing, in dung of about that age, whilst eggs have actually been found in dung lying in hot sunshine and known to be as young as $4\frac{1}{2}$ hours. On the other hand flies were on another occasion observed ovipositing in dung known to be that of the day before.

As a result of a large number of observations I would now say that "house-flies oviposit upon cow dung when it has formed a thin leathery crust." This crust may become suitable any time between 4 and 24 hours, but if, from weather conditions or shade, its formation is delayed much beyond this time it becomes unattractive to the adult fly as a medium on which to oviposit.

In confirmation of this latter it was observed that dung dropped in the shade at 10.30 a.m. of the 23rd, had a suitable crust at 10.20 a.m. of the 25th, two days later. No eggs were however found in it and it did not seem to attract flies. It had also been observed that dung dropped in the open, on very hot, dry days, frequently forms its crust so quickly that it is not used, possibly because not found, by the house-flies, but only bred *Sarcophagidæ*. In wet weather the formation of the crust is generally so delayed that the droppings are not used by the house-fly to breed in.

Observations carried out to try to show how long the dung remained suitable for the flies to oviposit upon were not very successful. In no case were unhatched eggs found the day following the one on which the first eggs were observed being deposited. Flies were one day observed on dung over 24 hours of age. No fresh eggs could however be found and their presence may have been due to a moist condition following heavy rain. Probably weather conditions influence the period that the dung remains suitable for ovipositing very considerably, but that period is undoubtedly normally only

* Since this was written I see that an attempt has just been made to introduce this bird into Hawaii.

a matter of a few hours. The nearest I was able to get to this time was on March 7th, when dung dropped in the early morning was found to be attracting flies at 10 o'clock, but no eggs could then be found. (The droppings would then vary from about 3 up to about 5 hours of age). At 2.30 p.m. eggs were present, unhatched and a few flies appeared to be still ovipositing. This would mean that the conditions probably remain suitable for from 4 to 6 hours according to the weather, and very little longer, as the crust was hardening fast. The day was sunny with some clouds and a light breeze. In the night slight rain fell slightly softening the crust. Despite this, however, the droppings did not attract any flies the following day.

In connection with the above, it is of interest that I observed, in the laboratory, that larvae which, from food shortage, were delayed in their development, failed to mature. If this applies in nature also, it would mean that any flies which oviposited late would lose their offspring and this would naturally tend to keep their ovipositing instinct to narrow limits in relation to the breeding medium.

APPENDIX B.

DATA OF BREEDING EXPERIMENTS WITH HOUSE FLIES IN LABORATORY.

Eggs laid in cow dung between 10 a.m. and 11 a.m. of February 3rd, 1928, hatched between 7 p.m. and 9 p.m. of the same day, giving an incubation period of about 9 hours with a temperature of 86° F., maximum falling to 74° F. at time of hatching.

In the field the first pupa was found on the 9th, but it is not absolutely certain that it was from this brood. The majority of the larvae had however pupated by the 11th and emerged as adults on the 16th and 17th.

Check experiments in the laboratory showed slightly slower development, pupation taking place chiefly on the 12th and 13th. The emergences were as follow (the pupal period can be averaged at 6 days):—

Date.	Emerg'd males.		Female.		Unknown.		Total.
17/2/28 ..	39	....	61	....	1	....	101
18/2/28 ..	78	....	87	....	25	....	190
19/2/28 ..	47	....	21	....	..	....	68
20/2/28 ..	11	....	2	....	..	....	13
	<u>175</u>	....	<u>172</u>	....	<u>26</u>	....	<u>372</u>

It will be observed that females were much in excess on the first two days and males on the last two. This order of emergence was unexpected and is not usual on other orders. It was partially supported in breeding out another large batch, where however the results were obscured by a big excess of males.

A considerable number of timed pupæ have given a very constant pupal period, in warm summer weather, of $5\frac{3}{4}$ to $6\frac{1}{4}$ days. This means that the above larvae took eight, nine and ten days to feed up, the majority taking nine.

A second big batch bred through in the laboratory on human fæces also took eight, nine and ten days for the larval period.

A third lot, in which the eggs were laid in cow dung on February 29th and which were supplied with an abundant supply of food, commenced to

pupate early on March 7th, being about 6 days 11 hours in the larval stage for the minimum, the whole pupating within the next 24 hours. The temperature was very warm and muggy during this period with a mean maximum of 87.5° F. and a mean minimum of 76.16° F. from February 29th to March 12th, when the first adults emerged. The whole period of this brood from egg to adult was 12 and 13 days. The emergences taking place as follows:—

Date and time.	Males.	Females.	Escaped.	Total.
12/3/28— 9.30 a.m.	35	39	..	74
11.30 a.m.	25	25	1	51
2.30 p.m.	8	3	..	11
13/3/28— 9 a.m.	13	10	1	24
10.30 a.m.	1	4	..	5
	82	81	2	165

All the above came from one batch of eggs, but not necessarily one parent. It therefore seems that the average larval period in normal summer weather is about 7 or 8 days, with a minimum of 6½ in very warm spells. The pupal period works out at about six days with a minimum of just over five in exceptionally warm periods. In the cool season both these times are likely to be considerably extended.

APPENDIX C.

EFFECT OF EXCESSIVE RAIN AND MOISTURE IN FLY PROBLEM.

A long spell of very wet weather lasting from the 16th March enabled some observations to be made upon the effect of such wet conditions upon the fly problem. Cow droppings were examined on the 29th, when it was found that the rain had so far prevented ovipositing that only in one instance were maggots found and then inly very few in number and no sarcophagids. The presence of the maggots in this one instance showed that the wet weather had largely prevented ovipositing, but had not rendered the drippings unfit for the development of the maggot. Wet weather may however lead to heavy mortality at the time that the maggots leave the manure to pupate, as it has been observed in the laboratory that when the surrounding soil is sodden the maggots continue to wander in search of a dry pupating spot for four, and even five days, but eventually pupate. Maggots removed and placed in dry conditions pupated within a few hours. The emergences showed that whereas those transferred maggots reached the adult stage as follows:—2 on 19th, 15 on 20th and 1 later (night of 20th), those left under moist conditions emerged as follows:—1 on 18th, 4 on 10th, 35 on 20th and 33 later (21st and 22nd). It will thus be seen that placed into dry conditions caused rapid pupation, whilst of those left under moist conditions half were delayed at least 24 hours.

A STOCKYARD TO HANDLE SMALL HERDS.

By C. R. TURBET, B.V.Sc., Government Veterinary Officer.

CATTLE which have been handled periodically are more tractable and require less time and labour to muster for shipment, branding, inspection, &c. They become accustomed to humans and are less trouble on plantations. Government Veterinary Officers are required to inspect all cattle periodically

but, in many cases, proper inspections cannot be made and much time is wasted on account of the lack of yarding facilities.

The following particulars are published to assist stock owners in constructing suitable stockyards for the convenience of owners and inspecting officers.

Site.—The stockyard should be accessible to homestead, and to grazing lands, to avoid the necessity of driving stock long distances, and for convenience in working. It should be on level slightly elevated land to provide good drainage. The corner of a large paddock is usually the best. The side fences of the paddock act as wing fences to assist in the mustering. If possible a good water supply should be in the vicinity.

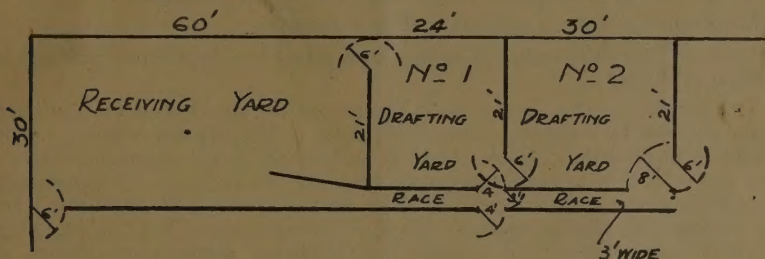
Fences.—These might be constructed of bush hardwood timbers of better quality. They should be stout, and bark and sap-wood should be cleaned off. The posts should be of good bush hardwood, with bark and sap-wood removed, and well dried; 9 in. by 8 ft. 6 in. when dry is a sufficient size. The butts should be tarred and sunk 2 ft. 6 in., panels 6 ft. to 8 ft. The fence rails should present a smooth surface to the inside of the stock-yard, and may be fastened by morticing, or by tying on with galvanized wire twisted tight on the outside. If the rails are tied on, the ends of the rails should well overlap each post. The rails should be so close together as to deter an animal from attempting to break through, and to hold calves. The height of the fence should be 6 ft.

Dimensions.—As provided in the plan, the receiving yard is 60 ft. by 30 ft. and should hold up to 100 mixed cattle. It is entered by a gate 6 ft. wide. From the right-hand corner of the end opposite the entrance gate, a race 3 ft. wide is continuous with the right-hand long side of the receiving yard. A wing fence 16 ft. long directs animals into the race. Twenty feet along the race, a gate should be constructed on each side of the race, opening on the left into the first drafting yard, and on the right into the open paddock. Immediately past these two gates (24 ft.) the race is blocked by a 3 ft. gate across the race, which when open provides a free passage along the race. At the end of the race on the left side an 8 ft. gate hung on the end post is provided, opening into the second drafting yard. The end of the race can be left open, or provided with bails for securing animals by the head for such operations as dehorning and ringing of bulls.

Gates.—These should be stoutly built of 6 in. by 1½ in. timber, well braced, and of the same height as the fences. They should in most cases be hinged so as to allow swinging in both directions. A good type of hinge which cannot be lifted off by charging cattle consists of two ring bolts. The ring of one, in the making, being included within the other like a link. One bolt is bolted right through the post, a large washer being included between the post and the nut. The ring of this bolt should be horizontal, the other bolt is bolted through the upright of the gate, which may need strengthening where the bolt goes through. A modification of this is to have instead of a bolt a flat piece of iron, which is pierced by smaller bolt holes. This is bolted to the gate after the manner of an ordinary hinge.

Explanation.—The stockyard, as designed, is sufficient to deal with about 100 head of cattle at one time. It can also be used for horses. The cattle are mustered into the receiving yard and passed into the race as required. The first series of three gates serve for drafting purposes, and can be operated by one man sitting on a cross beam above the race. Three classes can be drafted, the class going to the right being released. Those to the left are held in the first drafting yard, and those passing through the gate across

the race are drafted into the second drafting yard through the large 8 ft. gate which is left open for the purpose. The gates connecting the three yards are arranged as follows:—



PLAN OF STOCKYARD

From the receiving yard into No. 1 drafting yard, the gate is to the left, *i.e.*, on the side away from the race. Between No. 1 and No. 2 drafting yards, the gate is on the side nearest to the race, for the convenience of men in passing along the outside of the race when passing animals through. The gate leading out of No. 2 drafting yard is also on the side nearest to the race, in order to give free access to the end of the race when handling animals by the head for dehorning, &c. The large 8 ft. gate at the left side of the end of the race is provided for the purpose of throwing animals for castration, branding, &c. The near fore and hind fetlocks being secured to the lowermost rail of the right side of the race, a rope is passed from around the off upper fore-leg over the withers to the left side. The gate is then opened; and the animal is thrown to the left by pulling it off its balance by the rope over the withers. The end of the race may either be provided with a slip-rails stop, or be provided with some system of strong bails for securing animals by the head for such operations as dehorning, ringing of bulls, ear-marking, treatment of the eyes, &c.

IMPORTATION OF STOCK FOR WHICH A PERIOD OF QUARANTINE IS REQUIRED.

THE attention of the public is drawn to a regulation recently made under the Foreign Animals Importation Ordinance 1886 reading as follows:—

“The importer of any animal for which a period of quarantine is prescribed shall obtain, not less than one month prior to the advertised date of arrival of the vessel by which it is intended to import the animal, the written permission of the Superintendent of Agriculture to import the same. Provided that animals, imported for immediate slaughter, shall be exempt from the provisions of this Regulation.”

The regulations at present provide for the quarantine of imported animals as follows:—

Horses.—From the United Kingdom, Ireland, Canada and the United States of America.

Asses.—From France, Spain and Portugal.

Cattle.—From New South Wales, Victoria, South Australia, Tasmania and New Zealand.

Sheep.—From New South Wales, Victoria, South Australia.

Goats and Swine. *—Tasmania and New Zealand.

*(Note.—The importation of swine from all of the Australian States is at present prohibited.)

The purpose of this regulation is to prevent the quarantine station being taxed beyond its capacity at any one time. The present station, as the attached importation figures show, is sufficiently large to accommodate a much greater flow of cattle than now comes to the Colony. It is not large enough however to accommodate more than fifty head at once and when an enterprising planter recently imported seventy-three head in one shipment it was necessary to arrange for temporary quarantine grounds on very short notice. Temporary quarantine grounds are open to objections and this regulation will afford greater security to cattle importers as a whole.

1922	..	..	19 head.
1923	..	..	94 head (including one shipment of 55 head.)
1924	..	..	70 head (including one shipment of 61 head.)
1925	..	..	26 head.
1926	..	..	29 head.
1927	..	..	6 head.
1928	(February)		84 head (including one shipment of 75 head.)

These figures show that during the past six years there have been only three occasions on which cattle in excess of 50 head have been imported at one time and that there is no justification for the expenditure of public funds, at the present time, for the extension of the Animal Quarantine Station.

TABLE OF CONTENTS.

See sep rec'd

PAGE

EDITORIAL	1
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EXTRACTS—

REVIEW OF THE WORK OF THE IMPERIAL AGRICULTURAL RESEARCH CONFERENCE, 1927, BY ITS CHAIRMAN, THE RT. HON. W. G. A. ORMSBY GORE, AS PRINTED IN THE FINAL REPORT OF THE CON- FERENCE	1
--	---

NOTES—

IMPORTATION OF NATIVE MATS INTO SAMOA	5
PINEAPPLE FIBRE	5
AN INQUIRY CONCERNING ESSENTIAL OILS	6
§ ENTOMOLOGICAL RECORDS	7

ARTICLES—

§ PARASITES INTRODUCED FROM TRINIDAD TO CONTROL COCONUT SCALE by <i>T. H. C. Taylor</i> , Entomologist, Coconut Committee	7
§ STAINED COTTON IN FIJI AND ITS CAUSES by <i>H. W. Simmonds</i> , F.E.S., Government Entomologist	10
§ THE HOUSE FLY PROBLEM IN FIJI by <i>H. W. Simmonds</i> , F.E.S., Government Entomologist	12
A STOCKYARD TO HANDLE SMALL HERDS by <i>C. R. Turbet</i> , B.V.Sc., Government Veterinary Officer.	23
IMPORTATION OF STOCK FOR WHICH A PERIOD OF QUARANTINE IS REQUIRED	25

